REMARKS

Claims 1-25 are pending in the application, are rejected, and are at issue.

Applicant's undersigned attorney and Andrew Goldfinch, the proprietor of the Assignee, LeisureTech Electronics Pty. Ltd., would like to thank Examiners Isen and Michalski for the courtesies extended during the interview on November 10, 2004. At the interview, applicant presented background information on LeisureTech's A-Bus system. Particularly, Mr. Goldfinch described how the A-Bus system has achieved commercial success notwithstanding customer reluctance for such a system. Applicant was requested to make this evidence of record. Also, applicant presented argument in support of non-obviousness of the invention even without the secondary considerations.

This Amendment addresses the claim objections presented in the Office action. Also, enclosed are a Declaration under 37 CFR 1.132 of Andrew Goldfinch presenting information discussed during the interview. (The Declaration is a faxed copy with initialed corrections.) Also enclosed is a Declaration under 37 CFR 1.132 of Jason Knott, the Editor-in-Chief of CE Pro, a leading trade publication for the custom electronics industry. These Declarations, both individually and collectively, provide a strong showing of commercial success. This commercial success is attributable to the merits of the claimed invention which is generally a distributed stereo audio system using a category 5 four-pair twisted cable to carry audio signals, system power and data and status signals on the four pairs from a power supply and source in one room to amplifier and speakers in another room. Particularly, the Declarations describe how LeisureTech overcame reluctance in the industry and provided a system which has been extremely successful as evidenced

by the present licensees of the system described in paragraph 19 of the Goldfinch Declaration and paragraph 7 of the Knott Declaration and the sales revenues outlined in paragraph 20 of the Goldfinch Declaration. Particularly, revenues for fiscal year 2000 were $0. Subsequently, revenues were about $1 million dollars for 2001, $3 million dollars for 2002, $37 million dollars for 2003 and $47 million dollars for 2004. This is strong showing of commercial success evidenced by the rapidly accelerating growth in the last two years. Moreover, the Declarations clearly establish a nexus between the sales of and acceptance of the A-Bus system and the merits of the invention as both are substantially synonymous.

With respect to the detailed action, paragraph 1 noted that entry of the amendment in claim 1 deleting "(or similar)" was not entered as this phrase did not appear in line 1 of claim 1. Initially, applicant notes that the amendment referred to was not filed on April 5, 2004. In fact, claim 1 was amended by a Preliminary Amendment filed upon entry into the U.S. National Stage on August 14, 1998. Particularly, the Preliminary Amendment stated "Please amend claim 1, in its first line, by deleting '(or similar)'". This term is used only once in claim 1. It is clear from the instructions included in the Preliminary Amendment what was intended to be amended as the claim, which is only a single sentence, only included one instance of this term. As such, applicant submits that the Amendment was made preliminarily, prior to any examination of this application. Nevertheless, for formality sake, claim 1 is shown herein as currently amended to delete this term "(or similar)".

The claim objections and Section 112 rejection are addressed with the above amendments. Withdrawal is requested.

Applicant traverses the rejection of claims 1-5, 7-10, 16-20, 23 and 25 as obvious over Lloyd ("Multi-room High-Fi Takes Control of the Home") in view of the Knekt System Installation Manual and further in view of Puvogel 4,733,389.

Independent claim 1 specifies a distributed stereo audio system including two or more speakers for the broadcast of stereo audio signals, a source of stereo audio signals, a stereo amplifier to amplify stereo audio signals and drive the speakers and a mains operated electrical power supply to provide power to the amplifier. The amplifier is located in the same room as the speakers and remote from the signal source and power supply. The amplifier is connected to the signal source and power supply by means of a category 5 four pair twisted cable which provides, in respective conductors of the twisted pairs, right channel audio signals from the signal source to the amplifier, left channel audio from the signal source to the amplifier and DC power from the power supplier to the amplifier.

None of the references, alone or in proper combination, discloses use of category 5 four pair twisted cable which carries signal sources to amplifiers in a stereo system and DC power from the power supply to the amplifier.

The Lloyd article describes a Knekt home entertainment system in which receivers are situated in each room and plug into a standard hi-fi system. As stated in the article, the system is designed to ". . . avoid laying bulky speaker cables throughout a house and pumping high-voltage currents across them from a centralized hi-fi system. Instead, we send unamplified signals across

the home on "balanced" cables, which avoids picking up interference from other household devices along the way."

Attached is a one page brochure of Linn Products Limited dated 1998 for a Knekt Line Receiver. This is the type of device that is placed in a secondary room. As noted, the receiver is locally powered from AC power supplied by a Linn mains adaptor. The Linn mains adaptor is a conventional AC adaptor plugged into a wall outlet for locally powering the receiver and internal amplifier circuits.

The Knekt system installation manual describes the Knekt system in the cited Lloyd article. Applicant refers to the paragraph in bold lettering at the bottom of page 6 of the installation manual which reads as follows:

> **Plan the wire route to *AVOID* (emphasis in original) running beside Mains/Power cables, appliances with motors, Dimmer switches, TV sets or anything that can produce Radio noise. We've seen Fans, Refrigerators and Dimmer switches totally confuse the system and degrade the sound!, so AVOID!!!!**

Page 14, under the heading "Bypassing wall sockets." includes a statement that "Mains should be supplied via normal sockets in the cupboard and a normal power cord to the products." Moreover, at page 24, under the heading "ROOM INSTALLATION.", the instructions indicate that the audio input should be connected to the RJ45 sockets. It otherwise indicates that the user should "Wire up mains (power amplifier if using the KNEKT line receiver) and speakers." Finally, page 29 under the heading "Basic Installation Points to REMEMBER!" includes the following sub-paragraph:

> **AVOID** running cables beside Mains/Power cables. Keep at least 6" away from these cables. This can add a huge amount of noise into the Remote control and/or Audio.

As is apparent from the installation manual for the KNEKT system, as well as information previously provided, the KNEKT system not only does not teach delivering power on the same cable as the audio signals, the user is instructed to *AVOID* running the power in proximity to the audio signals.

The above instructions were discussed with Examiner Michalski during a telephone interview on September 8, 2004. The Examiner took the position that these statements in the KNEKT installation manual were referring to AC power, rather than DC power which is recited in claim 1. Applicant disagrees. There is no limitation in the KNEKT system installation manual limiting the restrictions to AC power.

Consistent with the restrictions in the KNEKT installation manual, enclosed is a print-out from a website relating to network cabling and referencing a CobraNet™ real-time digital audio distribution system. Particularly, this describes network cabling used for Ethernet connections. Of note is the section on network performance bridging pages 4 and 5 which discusses, in connection with an Ethernet network, routing the category 5 cable spaced from power lines or electrical equipment. Thus, even when category 5 cable is used in its conventional Ethernet application, the same considerations on avoiding proximity to power are maintained.

Regarding the issue of AC vs. DC power, applicant's attorney pointed out the fact that while theoretically DC power is direct current at a specific level, in fact DC power is also noisy. By way of example, enclosed is a print-out from a website of Prodigit Electronics Co. Ltd. entitled "PAN-403 How to test Noise from the Output of Power Supply". Figure 1 shows a typical DC power supply output showing that the DC output is in effect a sinusoid with a DC bias. Moreover,

the sinusoid is itself noisy. In fact, output noise is more particularly illustrated in Figure 8 on page 6.

The KNEKT system installation manual specifies that power line and sources be at least 6" from the category 5 cable. For the sake of argument, one can assume, as the Examiner has done, that this restriction relates only to AC power. In the case of a category 5 cable, the eight wires are all housed in a single jacket. Spacing between individual wires is limited only by the insulation thickness of respective wires. As such, the conductors themselves are perhaps about 1/16" apart. While the noise from a DC power supply might be less than that from an AC signal, the proximity of about 1/16", compared to the 6" restriction of KNEKT, could certainly introduce noise into the category 5 audio signal line. As such, applicant submits that a proper reading of the restrictions in the KNEKT system installation manual would instruct a user to avoid running even DC power in the same cable as the audio systems.

Puvogel discloses a custom drop cable for data and power for a local area network. The cable is not a category 5 cable. Instead, it is a customized variant of the ethernet drop cable specified by IEEE 802.3. The only similarity between this ethernet drop cable and category 5 cable is that both use twisted pairs. In fact, the drop cable uses five twisted pairs each being individually shielded and grounded, and the overall cable being shielded and grounded. This is apparent in Fig. 1 showing three terminations for each pair. Thus, the cable must be used with a connector having 15 termination points plus a grounded connector housing. Moreover, the DC voltage on the fourth pair provides power for operation of a transceiver.

The shields of the twisted pair cable used in Puvogel stops interference of radio and other electrical frequencies from corrupting data flow on the signal lines. The category 5 cable in the KNEKT system includes no such shielding. Also, the KNEKT audio system is a completely different application from the Puvagel network system. It is clearly improper to combine a disclosure of an ethernet drop cable and a cable used in a distributed stereo system which transmits audio signals.

In support of the rejection, the action considers only the fact that the KNEKT system uses category 5 cable for transmitting audio signals. The action ignores the express teachings in the KNEKT system manual that teach away from carrying power, not only on any of the pairs, but even in proximity to the category 5 cable. As is currently required by the MPEP §2141.02:

> A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. (citation omitted)

Moreover, the Court of Appeals for the Federal Circuit in In Re Francis S. Gurley, 27 F.3d 551, 553 (Fed. Cir. 1994) stated:

> "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant. The degree of teaching away will of course depend on the particular facts; in general, a reference will teach away if it suggests that the line of development flowing from the reference's disclosure is unlikely to be productive of the results sought by applicant." (citations omitted)

One skilled in the art considering the teachings of the KNEKT installation manual would give no consideration to carrying power on one of the pairs of the category 5 cable. For this reason alone, the combination is improper. It is improper to pick and choose only portions of the KNEKT system disclosure in support of the rejection, while excluding portions of the reference that teach away from applicant's invention.

The cable in Puvogel uses shielding to enable the cable to transmit audio and power. The category 5 cable in the KNEKT system includes no shielding. Nor is shielding possible, as the specified connector does not provide terminations for any shielding. For this reason also, one skilled in the art would not consider combining the teachings of these references.

Additionally, Puvogel discusses transmitting power on a twisted pair for powering a transceiver. The transceiver is used to provide a drop connection from a network device to an Ethernet coaxial cable. The transceiver is not an audio power amplifier. The claimed invention specifies transmitting power for powering an audio amplifier. Applicant submits that the teaching in Puvogel of transmitting power for powering a transceiver does not provide a teaching of supplying sufficient power for amplification as would be required in the KNEKT system or the claimed system. In fact, the KNEKT system requires connection to an AC outlet. The combination is improper for this reason as well.

In contrast to the cited references, the invention defined by claim 1 is based on the realization that both stereo audio signals and appropriate power signals can be transmitted simultaneously through a category 5 four twisted pair cable in a distributed stereo audio system. This realization enables such distributed stereo audio systems to be commercially viable, since the

category 5 cable is readily available and requires no special hardware or software terminators. The invention is not obvious in that it would not generally be expected to be suitable because the high bandwidth twisted pairs are not expected to be able to carry power signals, and if they were expected to be able to cope with power signals, the expectation is that they would cause interference in the accompanying, unshielded signal carrying pairs. It is surprising and inventive that this has turned out to be so in that the cable has proven to be highly suitable for this unexpected purpose.

For the above reasons, independent claim 1 is not obvious over the cited references.

Because claim 1 is not obvious, the remaining claims, which depend therefrom, are likewise not obvious.

For the above reasons, claims 1-5, 7-10, 16-20, 23 and 25 are believed allowable and withdrawal of the rejection is requested.

The action includes rejections to claims 6 and 21 and separately claims 11-15, 22 and 24, based principally on the references discussed above. The action cites a secondary reference for disclosing a room control amplifier mounted flush on the wall. The reference is not cited for any teaching with respect to a category 5 cable carrying power. Therefore, the reference does not supply the deficiencies noted above. Because independent claim 1 is allowable, dependent claims 6 and 21, and claims 11-15, 22 and 24, are not obvious and the rejections are improper and ought be withdrawn.

Reconsideration of the application and allowance and passage to issue are requested.

Respectfully submitted,

Date: December 2, 2004

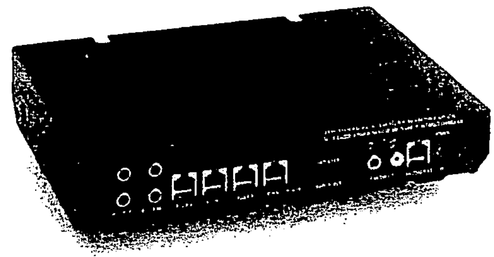
F. William McLaughlin
Reg. No. 32,273

WOOD, PHILLIPS, KATZ,
CLARK AND MORTIMER
Citicorp Center, Suite 3800
500 W. Madison Street
Chicago, IL 60661-2511
(312) 876-1800

KNEKT LINE RECEIVER

Enables a secondary room to receive source and control signals from the primary system.

Key Features



- Provides three line-level inputs to add local sources in a secondary room
- Available as a stand-alone unit or in 'Sneaky' module form for use in a Majik control amplifier or a Wakonda preamplifier
- Simple, powerful, low-cost preamplifier when used with KNEKT RCU.

Technical Specifications

Input Connectors: RJ45 ; RCA Phono (for local inputs)

Maximum Input Level: 5Vrms

Power Supply: 15-20Vac 0.5A max from a Linn mains adapter

Power Consumption: under 5W

Size: W 180 x D 244 x H 45mm

Weight: 1kg

LINN
the only sound

Linn Products Limited, Floors Road, Waterfoot, Glasgow G76 0EP, Scotland
Tel: (141) 307 7777 Fax: (141) 644 4262
e-mail: helpline@linn.co.uk http://www.linn.co.uk

PAN-403 How to test Noise from the Output of Power Supply.

1. Forewords:

Nowadays, switching power supply have replaced traditional linear power supply, become the power source of most electronics equipment. It being used in the desktop computer, monitor, printer, notebook computer, fax machine, photocopy machine and etc. The reason is because the advantage of smaller size, weight less and high efficiency, however, the bad thing of it is the noisy output. This article will discuss about the noise in switching power supply with DC output.

1.1. Definition:

Definition of output noise: the noise looks like a sine wave which overlaps on the DC output, this sine wave contain PARD (Periodic And Randdom Deviation) noise and it looks like the wave in Figure 1.

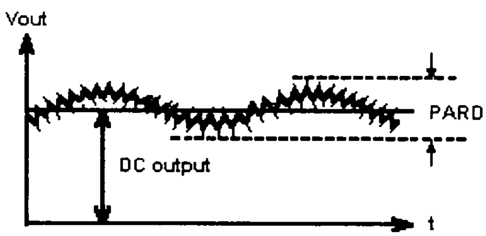


Figure 1 switching power supply's output noise

Since switching power supply use high switching frequency (>20kHz), accompany by PWM (Pulse Width Modulation) and output filtering circuit, it can transform the household electricity (AC) into DC voltage which IC circuit need, for example +5V, +12V, -5V, -12V, +3.3V, and so on. The only problem with the switching power supply is some sine wave in the DC output. If this sine wave (will call noise from now on) is large enough, it will cause malfunction in the application circuitry. We use 5V for example, if the noise is 1.0Vp-p, it will exceed the 4.75V-5.25V tolerance (a normal working voltage for logic IC), which can cause malfunction or system shutdown, therefore output noise has a lot of influence. Normally the output noise of switching power supply is control under 1% of the output voltage, for example for +5V, +12V, its' output noise specification should be 50mVp-p and 120mVp-p.

1.2. Controlling Output Noise:

When developing a switching power supply, the output noise has to be set within a certain specification. During production, things like the parts (such as transformer, diode, filtering capacitor and so on) with different material, incorrect assemble, missing parts and so on that cause noise level over the specification. To avoid these problems, checking output noise of each switching power supply is a must during quality control.

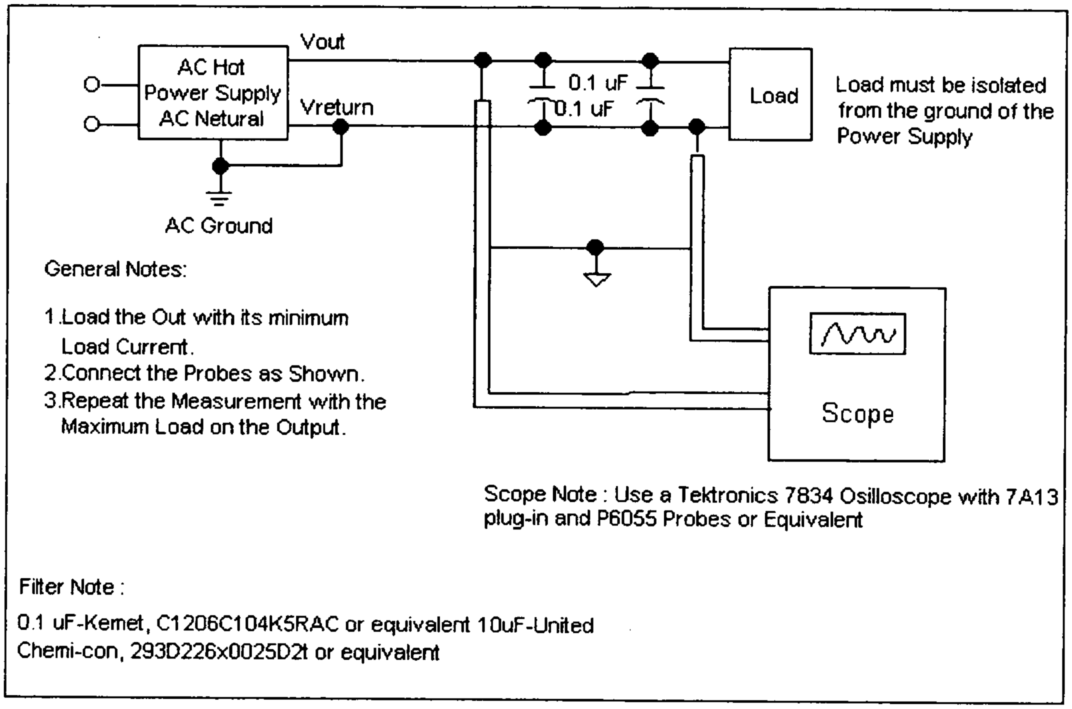
2. Output Noise Testing:

The testing equipment can be either oscilloscope or ripple/noise meter, the differences are describe as follow:

2.1. Oscilloscope:

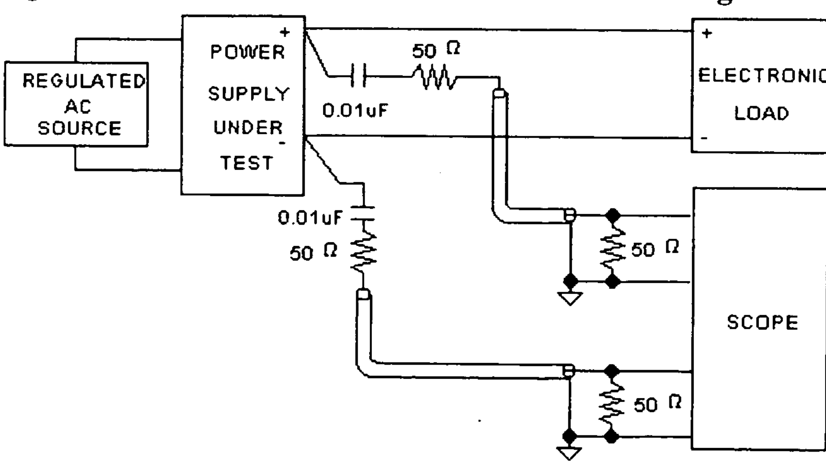
This is the most popular equipment use for testing, but pay attention to following condition otherwise the test result will not be accurate.

2.1.1. Avoid Ground Return: Differential input oscilloscope should be used, because the BNC negative input in general oscilloscope is connected to the case of the oscilloscope, and the case of the oscilloscope is connected to outside line ground. If use a probe to measure the DC output, it can cause ground return current which will affect the measurement. Because of that, ground return should be avoided. Using a differential oscilloscope or oscilloscope with a external differential amplifier is the correct method for testing connection, see figure 2, INTEL suggested test connection method., figure 3, HP suggested test connection method. Both INTEL and HP suggestion use differential oscilloscope; HP differential amplifier is shown in figure 4, as Tek differential probe is shown in figure 5.

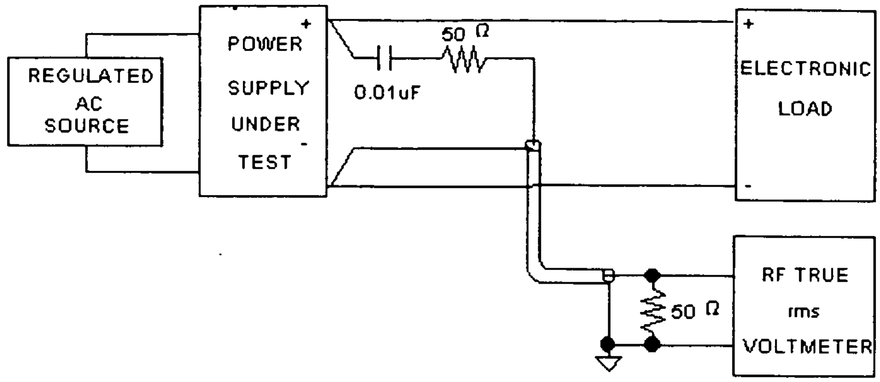


Note: 7A13 plug-in is differential amplifier

Figure 2 PARD differential mode test connection diagram suggested by INTEL



A.PEAK-TO-PEAK MEASUREMENTS



B. rms PARD MEASUREMENTS

Figure 3 PARD differential mode test connection diagram suggested by HP

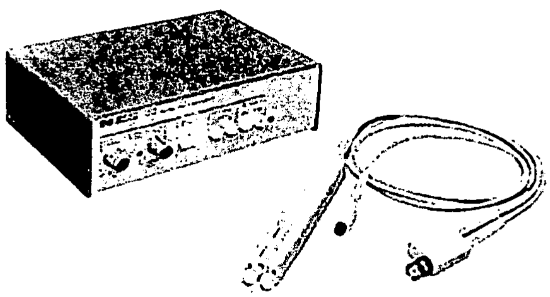
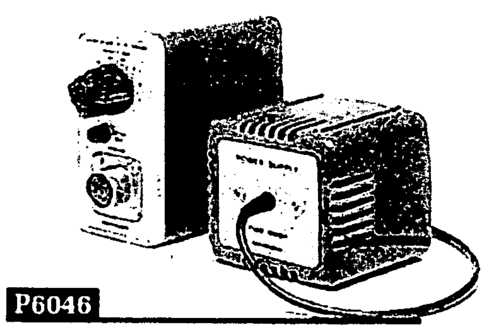
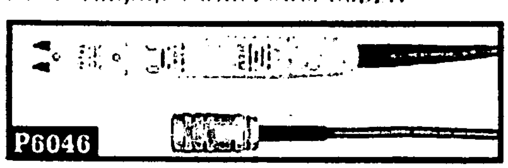


Figure 4 HP 1141A Differential Probe with HP 1142A Power Supply



P6046 Amplifier with Power Supply



P6046 with 10X Attenuator

Figure 5 Tek P6046 Active Differential System

2.1.2. Test Condition:

When adding capacitor to the terminal during test, the capacitor should be mentioned which include its material, capacitance and etc., like figure 2 which INTEL add 10uF and 0.1uF

capacitor in order to simulate the capacitance on the main board. There is no rule set for this test procedure, it is all depend on the condition. The capacitor should be mentioned if it is used during test, like figure A and figure B recommended connecting method, otherwise there will be big difference in the test results.

2.1.3. Frequency Bandwidth:
The frequency bandwidth of the oscilloscope will affect the test result, usually the standard is 20MHz, or 30MHz (INTEL test requirement), the sampling frequency for digital oscilloscope should be more than twice of the PARD frequency.

2.1.4. Input Resistance:
Usually we use 50 Ohm. For low input resistance like 50 (the oscilloscope can be set to 1M) at the terminal for the purpose of eliminating the signal interference. There is no specific requirement for this part, but the input resistance should be mentioned, otherwise there will be big difference in the test results too.

2.2 Ripple and Noise Meter:
Due to the reason that most of the oscilloscope have only two channel, it would be difficult to monitor the power supply with many output, addition disadvantage like it need human eye to observe and compare, and high cost. Therefore using Prodigit 4030 (up to 4 channel) with ripple noise meter, it can do the test in one time with upper and lower limit shown, plus the cost is reasonable (much cheaper than oscilloscope), so this is a very good test equipment, 4030 function block diagram is shown in figure 6. Its main specification is described as below:

4030 Ripple/Noise (Peak to Peak) Meter Block Diagram

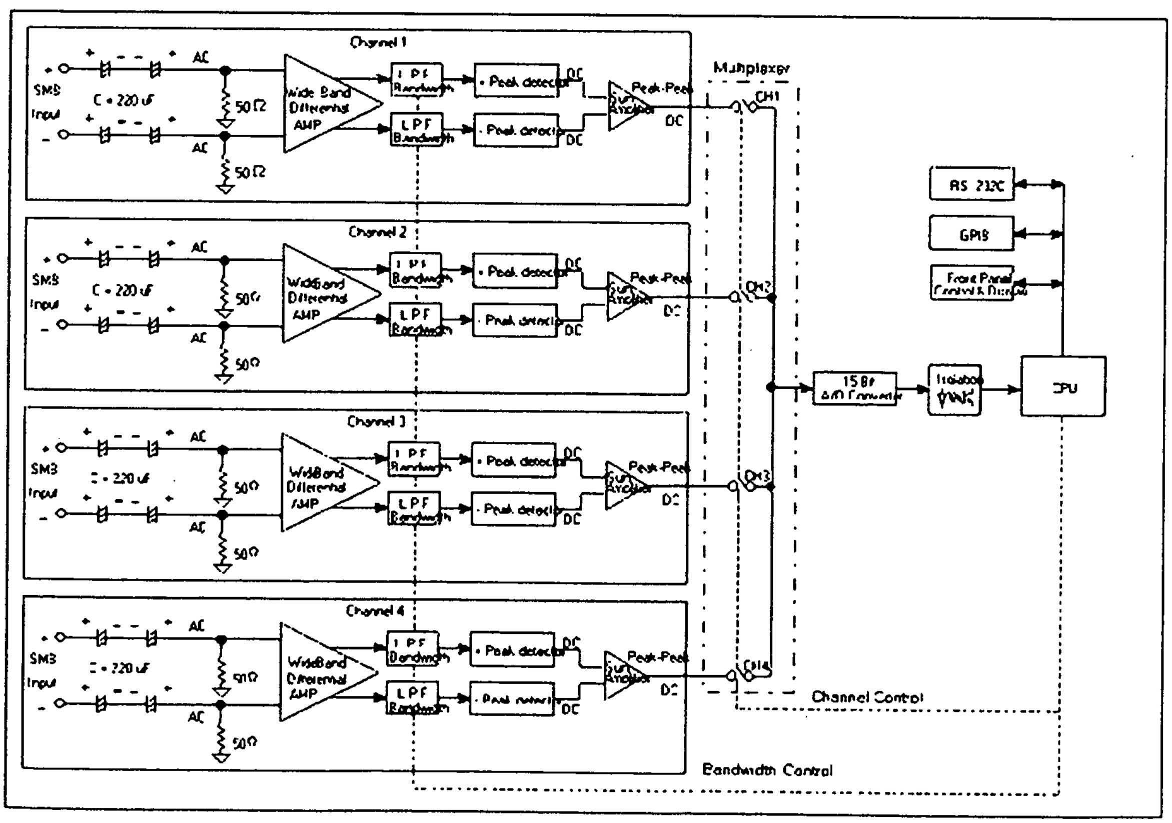


Figure 6 4030 Function Block Diagram (Large picture)

2.2.1. Input Structure:

Like the oscilloscope description, the connection should avoid ground return, therefore It is necessary to use differential mode, and the input resistance normally is 50W (which can effectively eliminate the input noise).

2.2.2. Input Range:

Usually, the specify noise for DC switching power supply output is 1% of its DC output, for example 5 volts DC output, its output noise should be less than 50mVp-p, for 12 volts DC output, the noise should be below 120mVp-p. Prodigit 4030 has 3 input range options to choose from when order, they are 3.0Vp-p, 1.5Vp-p, 0.75Vp-p respectively. Normally for 5V, 12V system voltage, choosing option with 0.75Vp-p input range should be enough, for 24V, 48V system voltage, 1.5Vp-p or 3.0Vp-p option should be chosen.

2.2.3. Frequency Bandwidth:

Prodigit 4030 Ripple/Noise meter include 3 frequency bandwidth for user to choose from, they are 20Hz~200KHz, 20Hz~2MHz and 20Hz~50MHz. 20Hz~50MHz is mainly for checking output noise, 20Hz~200KHz or 20Hz~2MHz is for checking output ripple or dynamic load over-shoot or under-shoot. Frequency bandwidth range of 20Hz~50MHz means 4030 meter can measure the response of peak to peak frequency range in input signal (noise). It usually means -3dB (0.707 X) frequency range. For example if the input signal is 100mVp-p, at 50 MHz, 4030 will measure 70.7mV or more. 4030 Ripple/Noise meter classic frequency respond is shown in figure 7.

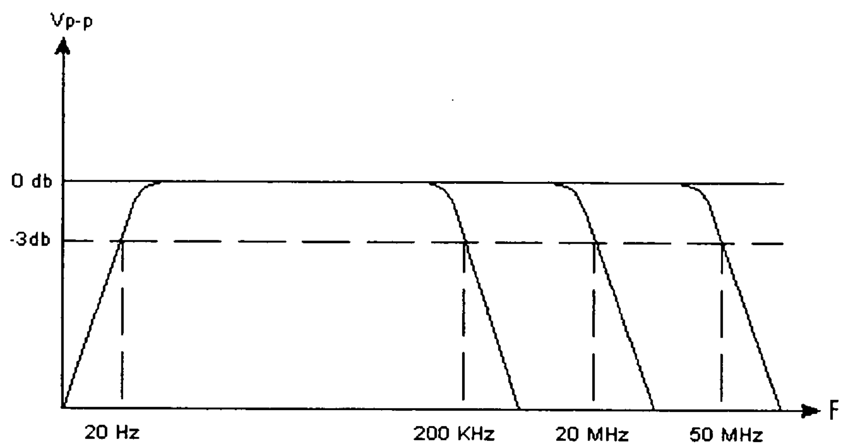


Figure 7 4030 ripple noise meter typical frequency respond

2.2.4. Frequency Spectrum of the Power Supply output noise:

Power supply output noise include many different frequency (like 50Hz, 60Hz ripple on off frequency) and other noise. If output noise has narrow and sharp FET with ON/OFF spike, it will contain many high frequency, we can use Spectrum Analyzer to observe the frequency contain, figure 8, 9 are the power supply output noise wave form and spectrum. When using 4030 Ripple/Noise meter to measure noise, picking different frequency bandwidth will cause its value to change. Normally, high frequency bandwidth (20Hz~50MHz) will result in higher value than using low frequency bandwidth.

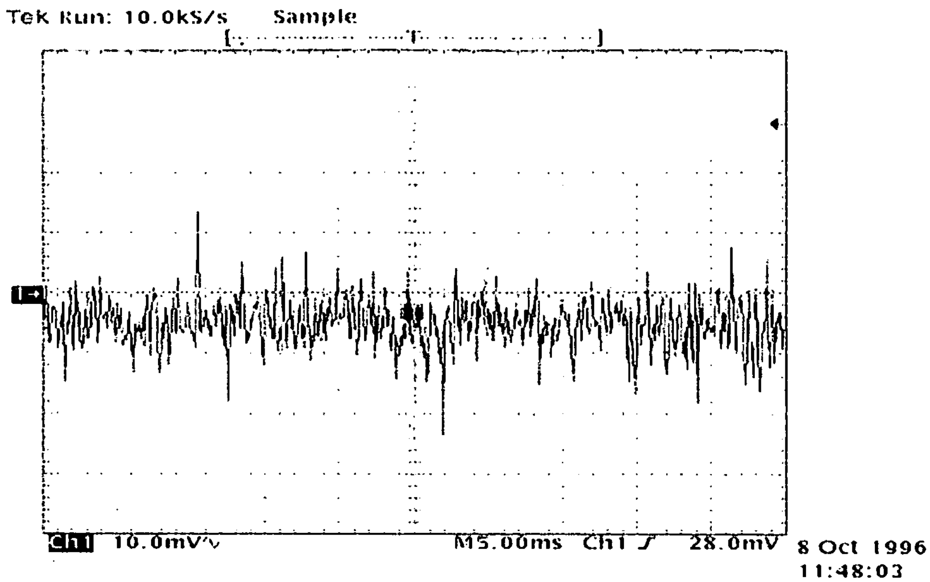


Figure 8 typical power supply output noise

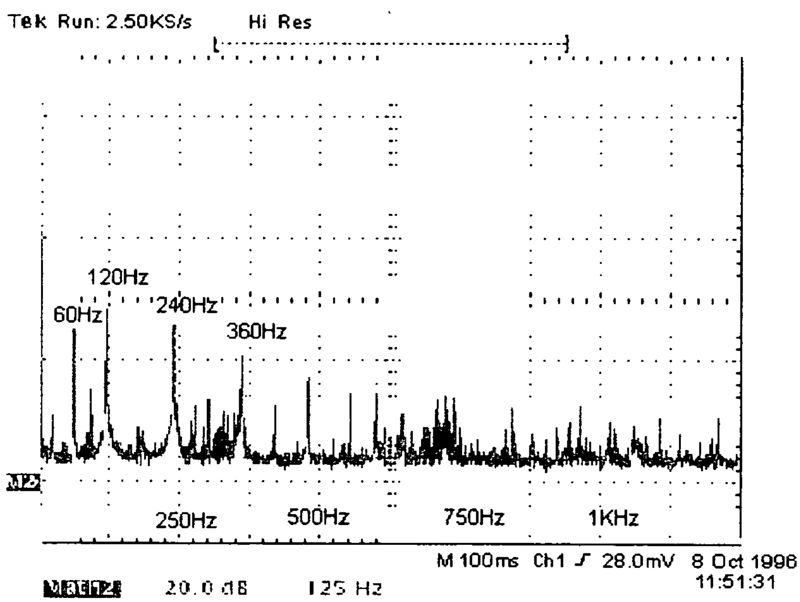


Figure 9 (A)

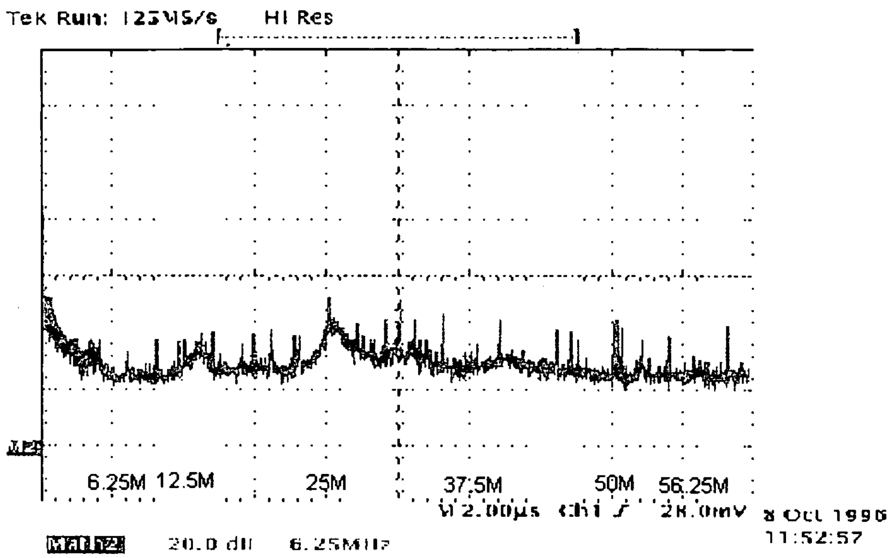


Figure 9 (B)

Figure 9 Typical power supply output noise's spectrum

2.2.5. How to Define Pass/Fail with 4030

4030 has the ability to measure and compare between the upper and lower limit. In every single PARD measure channel, when measure value is within upper and lower limit, it will give a GO or Pass, if measure value is outside the upper and lower limit, it will give a NG or Fail; if all four PARD measure channel pass, green LED that shows PASS on the panel will light up, if there is one fail the red LED that shows FAIL will light up on the panel, to show that it doesn't pass the test condition. Every 4030 PARD measuring channel has its own upper and lower limit value, operator can set its value individually, its PASS/FAIL comparison function block diagram is shown in figure 10.

Note: 4030 panel will light up green PASS LED when pass, red FAIL LED will light up when fail.

If using logic symbol to represent, the result will be like as follow:

PASS = (PARD1L¡ØPARD1¡ØPARD1H) AND (PARD2L¡ØPARD2¡ØPARD2H) AND (PARD3L¡ØPARD3¡ØPARD3H) AND (PARD4L¡ØPARD4¡ØPARD4H)
FAIL = (PARD1L¡ÖPARD1) OR (PARD1¡ÖPARD1H) OR (PARD2L¡ÖPARD2) OR (PARD2¡ÖPARD2H) OR (PARD3L¡ÖPARD3) OR (PARD3¡ÖPARD3H) OR (PARD4L¡ÖPARD4) OR (PARD4¡ÖPARD4H)

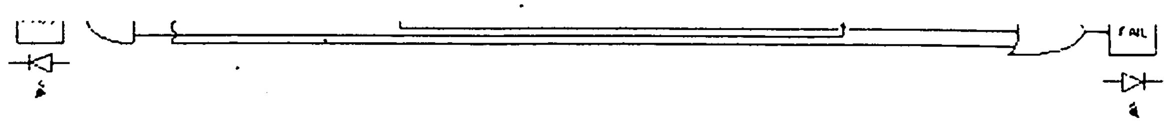


Figure 10 4030 PASS/FAIL function comparison block diagram (Large picture)

2.2.6. Checking Connecting Cable:

4030 includes eight SMB high frequency cable and sixteen SMB connector, providing connection between 4030 Ripple/Noise meter and test power supply, its connecting method can be found in 4030 operating manual. Prodigit also prepare the optional fixture Model 9951 (P/N: 65233005), cost US$10.00 /pc, which is shown in figure 11 for PC power supply, so that the user immediately connect the power supply to the 4030

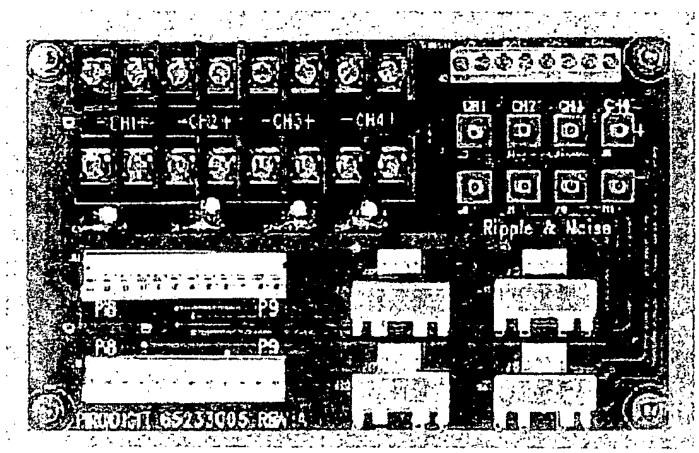


Figure 11: 9951 PC Fixture with SMB connector

3. Conclusion:

3.1. Suitability:

4030 Ripple/Noise meter include four channel of noise measure circuit, it can measure four output from power supply simultaneously. If the output of the power supply is more than four set, two 4030 can provide up to 8 set of noise measurement simultaneously, therefore it will solve insufficient input channel problem.

3.2. Input Structure:

4030/3600A equipment with differential input structure, which can avoid ground return problem, addition advantage like the low cost and ease of use. This can improve the problem of expensive differential probe and hard to use.

3.3. Definition:

4030/3600A equipment with PASS/FAIL define mechanism which improve the difficulty in defining pass and fail using oscilloscope. This is very suitable for quality control and checking on production line.

3.4. System Expansion:

4030 equipment with RS-232C & GPIB interface, and 3600A equipment with RS-232C interface, which can use program to control. It is suitable for manually, computer, or automatic control testing.

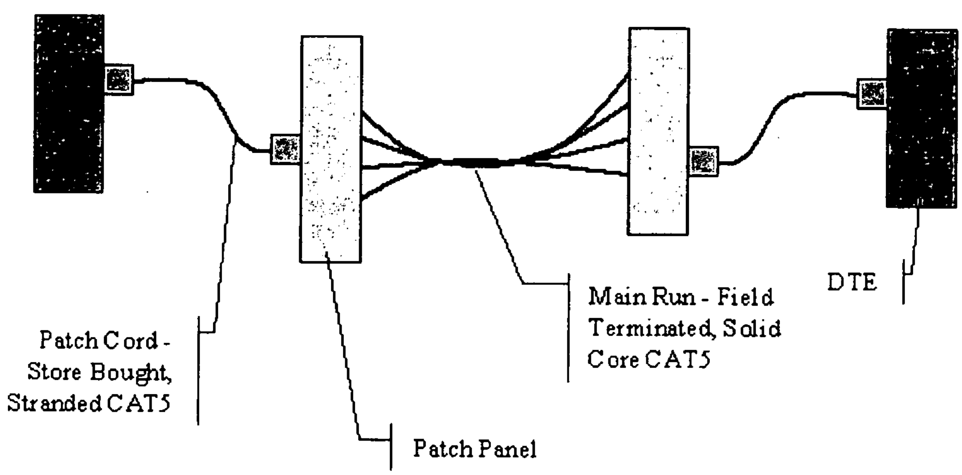
[Go to Top][Home]

Network Cabling

This page is primarily targeted at audio industry professionals who may not have experience designing or installing network cable plants. It provides some quick tips and a general overview of cable plant considerations that will help lead to a high-quality network installation.

Cable Plant - back to top

A typical Ethernet network cable path is shown below. It is considered good design practice to include the intermediate patch points as shown. This gives the cable plant operator flexibility in accommodating expansion and configuration changes.



CAT5 Cabling Issues - back to top

Distance Limitations

Ethernet networks use unshielded twisted pair (UTP) Category 5 cable. CAT5 cable runs should not exceed 100 meters.

Connectors

There are two different types of RJ-45 connectors. There is the "bent tyne" connector intended for use with solid core CAT5, and then there is the "aligned tyne" connector for use with stranded CAT5 cable. Errors have popped up when using incorrect cable/connector combinations. The "bent tyne" connector will work just fine on stranded wire by the way, just not the other way around. In general, make sure your connector matches you cable type...

Twists and Terminations

When terminating CAT5 UTP cable, it is important that the natural twist of each pair be carried through as close as possible to the point of termination. EIA/TIA standard 568B requires no more than 1/2 inch be left untwisted for Category 5. More than 1/2 inch of untwisted cable will affect performance at high bit rates.

Although only 2 of the 4 twisted pairs are used for Ethernet, it is important that *all pairs be terminated*, and that the proper wires be twisted together. Standards set forth by **EIA/TIA 568A/568B** and **AT&T 258A** define the acceptable wiring and color-coding schemes for CAT5 cables.

Pin	Signal	EIA/TIA 568A	EIA/TIA 568B	Ethernet
1	Transmit +	White/Green	White/Orange	X
2	Transmit -	Green/White or Green	Orange/White or Orange	X
3	Receive +	White/Orange	White/Green	X
4	N/A	Blue/White or Blue	Blue/White or Blue	Not Used
5	N/A	White/Blue	White/Blue	Not Used
6	Receive -	Orange/White or Orange	Green/White or Green	X
7	N/A	White/Brown	White/Brown	Not Used
8	N/A	Brown/White or Brown	Brown/White or Brown	Not Used

Wiring/Color Coding for CAT5 Cable

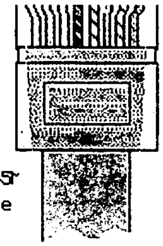
CAT5 cables are typically terminated with RJ-45 connectors. Two types of RJ-45 connectors exist: the bent tyne and aligned tynes varieties. The aligned tyne version is intended for use with stranded cable. The bent tyne version, although intended for use with solid core cable, may also be used with stranded.

Straight-through vs. Crossover Cables

Two types of CAT5 cables are typically used in a network: the straight-through cable and the crossover cable. The difference between the two has to do with how the conductors terminate to the RJ-45 connector at each end of the cable. The chart below shows the RJ-45 connector "pin-outs" for CAT5 crossover and straight-through cables.

RJ-45 PIN	RJ-45 PIN	RJ-45 PIN	RJ-45 PIN
1 Rx+	3 Tx+	1 Tx+	1 Rc+
2 Rc-	6 Tx-	2 Tx-	2 Rc-
3 Tx+	1 Rc+	3 Rc+	3 Tx+
6 Tx-	2 Rc-	6 Rc-	6 Tx-

RJ-45 Male



AT&T 258A - EIA/TIA 568B

RJ-45 Connector "Pin-Outs"

A straight-through cable is used to connect a DTE, like a CobraNet device, to a switch. The transmit pins on the CobraNet device connect directly to the receive pins on the switch and vice versa (i.e., pin 1 to pin 1, pin 2 to pin 2, pin 3 to pin 3, etc. as shown in the above graphic). Crossover cables are used to connect switches to other switches. In crossover cables, the pins are "swapped" at one end (i.e., pin 1 to pin 3, pin 2 to pin 6, pin 3 to pin1, and pin 6 to pin 2) to allow the transmit of one switch to connect to the receive of the other. Note that the same rules for crossover and straight-through cables also apply for hub-based networks.

It is very easy to tell the difference between a crossover cable and a straight-through cable by looking at the conductors in the RJ-45 connectors. If the wiring is identical at both ends, you are holding a straight-through cable, if it is different, you most likely have a crossover cable.

Crossover Cables and Uplink Ports

Some hubs and switches contain uplink ports. These ports are intended to serve as a connection to another switch or hub. As such, the uplink port is wired to use a straight-through instead of requiring a crossover cable. On some switches and hubs uplink ports share their connection with an adjacent port, so be sure to read the manufacturers instructions for proper use.

Fiber Optic Cable - back to top

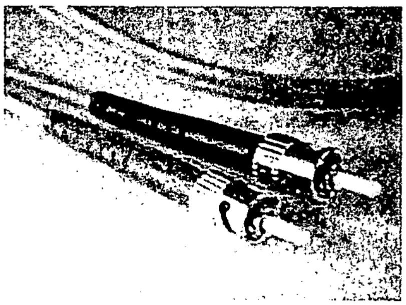
General

Both single mode and multimode fiber optic cable may be used in Ethernet network designs. Although multi-mode fiber has a specific distance limitation of 2km, distance limitations of single-mode fiber vary according to the proprietary system in use. All are in excess of 2km. Single mode fiber systems tend to be more expensive than multimode systems. This is due primarily to the fact that lasers are used as light sources in single mode transceivers instead of LEDs. For this reason, it is not possible to achieve greater distance runs simply by swapping multimode for single mode fiber - the fiber transceivers must also be changed.

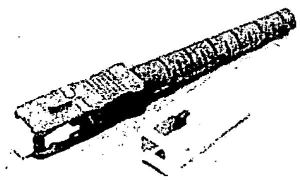
Remember that there is no auto-negotiation over fiber. This means that manual configuration of fiber ports is necessary to guarantee proper operation of your CobraNet network.

Connectors

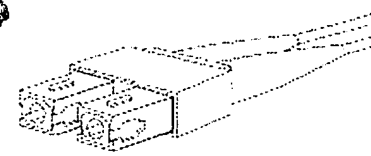
There are two common types of fiber optic connectors: SC and ST. The ST or "straight tip" connector is the most common connector used with fiber optic cable, although this is no longer the case for use with Ethernet. It is barrel shaped, similar to a BNC connector, and was developed by AT&T. A newer connector, the SC, is becoming more and more popular. It has a squared face and is thought to be easier to connect in a confined space. The SC is the connector type found on most Ethernet switch fiber modules and is the connector of choice for 100Mbit and Gigabit Ethernet. A duplex version of the SC connector is also available, which is keyed to prevent the TX and RX fibers being incorrectly connected.



ST or Straight Connector

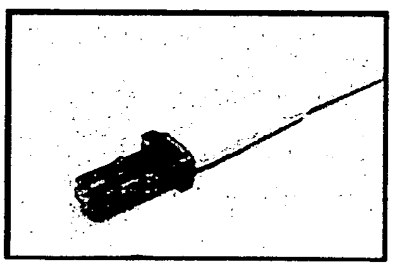


SC Connector

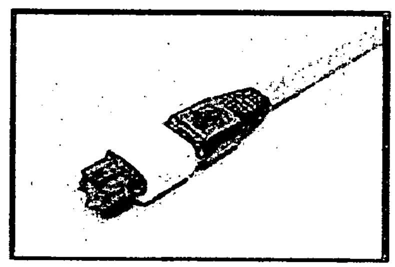


Duplex SC Connector

There are two more fiber connectors that we may see more of in the future. These are the MTRJ and MTP. They are both duplex connectors and are approximately the size of an RJ45 connector.



MTRJ Connector



MTP Connector

Network Performance - back to top

A number of factors can degrade the performance of your Ethernet network, and among these is a poor cable plant. Cabling problems and a susceptibility to EMI can actually lead to packet loss. Because CobraNet traffic is more sensitive to packet loss than typical datacom traffic, it is important that cable plant quality not be sacrificed. The following sections present cabling considerations that will help to ensure a high-quality cable plant installation.

Similar to audio cabling, there are certain proximity specifications to be aware of when designing your network cable routes. The following chart lists some CAT5 proximity guidelines. For fiber optic cable runs, these guidelines are no longer a concern due to fiber's inherent immunity to EMI and RFI.

Condition	<2kVA	2-5kVA	>5kVA
Unshielded power lines or electrical equipment in	5 in. (12.7 cm)	12 in. (30.5 cm)	24 in. (61 cm)

proximity to open or non-metal pathways			
Unshielded power lines or electrical equipment in proximity to grounded metal conduit pathway	2.5 in. (6.4 cm)	6 in. (15.2 cm)	12 in. (30.5 cm)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway	N/A	6 in. (15.2 cm)	12 in. (30.5 cm)
Transformers and electric motors	40 in. (1.02 m)	40 in. (1.02 m)	40 in. (1.02 m)
Fluorescent lighting	12 in. (30.5 cm)	12 in. (30.5 cm)	12 in. (30.5 cm)

Proximity Specifications

CAT5 and Cable Ties

Another factor that can degrade the installation quality is snug cable ties. Ties should never be pulled tight enough to deform the outer jacket of the UTP cable. Doing so produces a slight change in the cable impedance at the point under the tie, which could lead to poor network performance. If tight ties are used at even intervals down the cable length, the performance degradation is even worse. Follow the link to an article by Belden (below) for a more detailed discussion of this issue.

Pull Force and Bend Radius

A common myth is that fiber optic cable is fragile. In fact, an optical fiber has greater tensile strength than copper or steel fibers of the same diameter. It is flexible, bends easily and resists most of the corrosive elements that attack copper cable. Some optical cables can withstand pulling forces of more than 150 pounds! The fact is, Category 5 cable may be more fragile than optical cables: tight cable ties, excessive untwisting at the connector, and sharp bends can all degrade the cable's performance until it no longer meets Category 5 performance requirements. While fiber may have a reputation for being more fragile than it really is, it still has limitations, and as such, care should be taken when installing both CAT5 and fiber optic cables. Here are some guidelines for CAT5 and fiber optic bend radius and pull force limitations:

CAT5

> All UTP cables have pull force limitations much lower than those tolerated in the audio industry. If more than 25 pounds of force is applied to CAT5 cable during installation, it may no longer meet specification. Like most audio cables, UTP cables also have minimum bend radius limitations. Generic CAT5 allows a minimum bend radius of 4 times the cable diameter or 1" for a 1/4" diameter cable. Note that this is a minimum bend *radius* and not a minimum bend *diameter*.

Fiber

The bend radius and pull force limitations of fiber vary greatly based on the type and number of fibers used. If no minimum bend radius is specified, one is usually safe in assuming a minimum radius of 10 times the outside diameter of the cable. For pulling force, limitations begin at around 50 lbs and can exceed a few hundred pounds. In general, it is recommended that you check with the fiber manufacturer for specifications on the specific cable used in your installation.

Additional Resources - back to top

One good way to keep up with current happenings in the field of cabling is to subscribe to *Cabling Installation & Maintenance* magazine. They are also a good source for training videos and reference books.

http://cim.pennwellnet.com/home/home.cfm

BiCSi (pronounced Bic See) publishes a Telecommunications Distribution Methods Manual which serves as the reference for their Registered Communications Distribution Designer Certification exam. They also Certify 3 levels of Installers. They offer training courses, videos, and books, and hold an annual convention.

http://www.bicsi.org/

This paper by Belden shows why a "neat" installation may not be a good idea, and defines some of the important tests done on UTP data cabling. It also shows that neatly bundling cables together (as is considered good practice in the audio industry) may actually degrade the performance of UTP cables.

http://bwcecom.belden.com/college/Techpprs/ieacectp.htm

While it's not your typical FAQ page, the Data Communications Cabling FAQ provides a good source for technical information on cabling, connectors, standards and testing. It also provides a thorough listing of contact information for manufacturers and standards organizations.

Search GO

Page Updated
8/12/04